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# PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-276173

(43)Date of publication of application : 13.10.1998

(51)Int.Cl.

H04J 14/00  
H04J 14/02  
G02B 6/293

(21)Application number : 09-078637

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(22)Date of filing : 28.03.1997

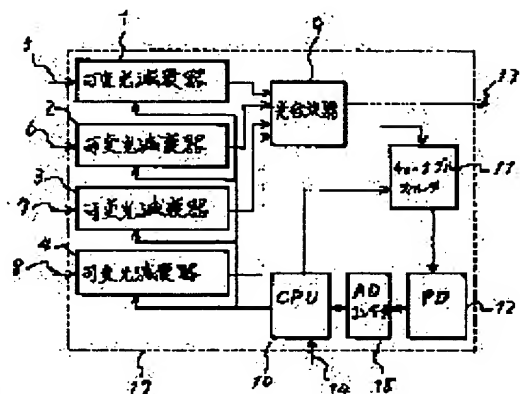
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## (54) OPTICAL MULTIPLEXING BOARD AND OPTICAL MULTIPLEXING METHOD

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To automatically and always adjust the levels of respective signal lights to be constant by detecting the levels of the respective signal light beams with a tunable filter and a light receiver and controlling respective variable light attenuators.

**SOLUTION:** The respective signal light beams are made incident on the input ports 5, 6, 7 and 8 of an optical multiplexing board 17 in ascending order of the wavelength. The four signal light beams are transmitted through the variable light attenuators 1, 2, 3 and 4 and are made incident on an optical multiplexer 9. The light transmittance of the respective variable light attenuators is set to be 100% as an initial state. The tunable filter 11 inputs one output of the optical multiplexer 9 and a PD 12 detects the input light level. A comparator 15 A/D-converts the level. CPU 10 controls the variable light attenuator 1 so that the output of the comparator 15 becomes the prescribed level when the tunable filter 11 is set to light wavelength inputted to the optical level input port 5. The variable light attenuators 2, 3 and 4 are similarly controlled and the light signals of the prescribed level is outputted from a light output port 13.



## LEGAL STATUS

[Date of request for examination] 28.03.1997

[Date of sending the examiner's decision of rejection] 18.04.2000

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's  
decision of rejection]

[Date of extinction of right]

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**CLAIMS**

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[Claim(s)]

[Claim 1] The optical multiplex board which is characterized by providing the following and which is made to input signal light from two or more input sections, respectively, carries out multiplex [ of the signal light of these plurality ], and outputs it. Two or more good light variation attenuators which signal light inputs. The optical multiplexing machine which multiplexes the output light from each good light variation attenuator. The tunable filter which the output light of the aforementioned optical multiplexing machine inputs. The optical light sensing portion which receives the output light from the aforementioned tunable filter, and the control section which controls each good light variation attenuator based on the output of the aforementioned optical light sensing portion.

[Claim 2] The optical multiplex board characterized by having the control panel which controls the optical receiving board which is made to input the signal light which outputs the optical multiplex board of a claim 1 from two or more preparations and each aforementioned optical multiplex board from two or more input sections, and carries out multiplex [ of such signal light ], and the optical receiving board of all above.

[Claim 3] The aforementioned optical multiplexing machine is the optical multiplex board according to claim 1 or 2 which had two output ports and the aforementioned tunable filter has connected to one output port.

[Claim 4] The output light of the aforementioned optical multiplexing machine is the optical multiplex board according to claim 1 or 2 which branches by the optical separator and one branching light inputs into the aforementioned tunable filter.

[Claim 5] The optical multiplex method characterized by adjusting the level of each signal light to predetermined level by making two or more signal light input through a good light variation attenuator, detecting the level of each signal light after carrying out wavelength multiplex [ of these ], and controlling the aforementioned good light variation attenuator.

[Claim 6] The optical multiplex method according to claim 5 which controls the aforementioned good light variation attenuator to detect the level of each signal light and to double the level of each signal light with the minimum level among these.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[The technical field to which invention belongs] this invention is used for the lightwave transmission system of wavelength multiplex system, and relates to the optical multiplex board which carries out multiplex [ of two or more signal light ].

[0001]

[Description of the Prior Art] In the lightwave transmission system of wavelength multiplex system, if a difference arises on the level of each signal light by which multiplex is carried out, the problem that signal light is correctly unreceivable by the receiving side will arise. The method of carrying out the monitor of the level of each light source of a transmitting side as a method of arranging the level of signal light, and adjusting to predetermined level is learned. On the other hand, in order to perform more exact level adjustment, the method of adjusting the level of each signal light in the optical multiplex board to which it carries out multiplex [ of the wavelength of two or more signal light ] in an optical transmission line is performed.

[0002] Drawing 3 shows the composition of the conventional optical multiplex board which has the above-mentioned function. Four sets of the manual good light variation attenuators 1, 2, 3, and 4 have connected with the optical multiplexing machine 9, and the optical spectrum analyzer 22 has connected with the output side of this optical multiplexing machine 9. In this multiplex board, a maintenance man measures the output level for every wavelength by the optical spectrum analyzer 22, adjusts each magnitude of attenuation of the good light variation attenuators 1, 2, 3, and 4 manually, and adjusts the level of each wavelength uniformly.

[0003]

[Problem(s) to be Solved by the Invention] However, in the conventional optical multiplex board, it is difficult to secure the maintenance man and measuring instrument which became skillful in work, and to always keep the level of each signal light constant as mentioned above.

[0004] The purpose of this invention is to offer the optical multiplex board which can automatic always adjust the level of each signal light uniformly.

[0005]

[Means for Solving the Problem] The optical multiplex board of this invention which attains the above-mentioned purpose has two or more good light-variation attenuators which signal light inputs, the optical multiplexing machine which multiplexes the output light from each good light-variation attenuator, the tunable filter which the output light of the aforementioned optical multiplexing machine inputs, the optical light sensing portion which detects the output light from the aforementioned tunable filter, and the control section which controls each good light-variation attenuator based on the output of the aforementioned optical light sensing portion. Moreover, it is the composition equipped with the control panel which other composition of the optical multiplex board of this invention inputs the above-mentioned optical multiplex board into two or more preparations, makes input such output light into the multiplex board of the above-mentioned composition further, and controls the multiplex board of these plurality.

[0006] Next, the optical multiplex method of this invention makes two or more signal light input through a good light variation attenuator, after it carries out wavelength multiplex [ of these ], it detects the level of each signal light, and it adjusts the level of each signal light to

predetermined level by controlling the aforementioned good light variation attenuator.

[0007] In this invention, since the level of each signal light is detected, a control section controls each good light variation attenuator and the level of each signal light is adjusted to a predetermined value by the tunable filter and the optical light sensing portion, the outstanding effect that level adjustment of signal light by which wavelength multiplex is carried out can be performed automatically and correctly is done so.

[0008]

[Embodiments of the Invention] Next, the gestalt of operation is explained to this invention using a drawing. Drawing 1 shows the basic composition of the optical multiplex board of this invention. The input section of the good light variation attenuators 1, 2, 3, and 4 has connected with four input port 5, 6, 7, and 8 of the optical multiplex board 17, respectively. The four above-mentioned good light variation attenuators 1, 2, 3, and 4 are connected to the optical multiplexing machine 9. The optical multiplexing machine 9 had two output ports, and has connected one output port to the optical output port 13 of the optical multiplex board 17. Moreover, the output port of another side of the optical multiplexing machine 9 is connected to a tunable filter 11. The photodiode (PD) 12, AD converter 15, and the control section (CPU) 10 have connected with a tunable filter 11 in this turn at series. It can connect with a tunable filter 11 and four good light variation attenuators 1, 2, 3, and 4, and CPU10 can control these. Moreover, the external-control port 14 for controlling this CPU10 from the exterior has connected with CPU10.

[0009] Next, the example of the above-mentioned optical multiplex board 17 of operation is explained. The signal light of short wavelength carries out incidence most to input port 5 first, and each signal light carries out incidence from short wavelength in the order of long wavelength to input port 6, 7, and 8 below. These four signal light penetrates the good light variation attenuators 1, 2, 3, and 4, respectively, and they carry out incidence to the optical multiplexing machine 9. The good light variation attenuator is taken as 100% of permeability as an initial state. The optical multiplexing machine 9 carries out wavelength multiplex [ of these four signal light ], and sends them out from two output ports. One wavelength multiplex light is sent out from the optical output port 13 of the optical multiplex board 17. Incidence of the wavelength multiplex light of another side is carried out to a tunable filter 11. It is controlled by CPU10 and the tunable filter 11 is driven so that the transparency property may be changed from the minimum-wavelength side of the wavelength multiplex light to a long wavelength side one by one. PD12 receives the signal light which penetrates a tunable filter 11, and sends the signal about the level to AD converter 15. AD converter 15 changes into a digital signal the signal which shows the level of this signal light, and sends it to CPU10. CPU10 is controlling the tunable filter 11 so that the first signal light which a tunable filter 11 carries out [ the light ] a scanning drive, and makes penetrate is minimum wavelength. Therefore, CPU10 controls the good light variation attenuator 1 to double the level of the first signal light with the predetermined reference level currently held. Since a tunable filter 11 makes signal light penetrate in order of wavelength below, above-mentioned operation is performed one by one also about the signal light of other wavelength.

[0010] Let predetermined reference level which the above CPU 10 holds be the level value of the minimum signal light of the four signal light. In this case, CPU detects the level of four signal light, before starting control of the good light variation attenuator 1, and it holds the minimum level value as a reference level value among such level. Values other than the above can also be chosen as a reference value. Moreover, the initial value of the good light variation attenuator 1 can also be made into a value smaller than 100% of permeability. Although it changes with designs of a system, when an about 0.2 to 0.3dB difference arises between the level of two or more signal light by which wavelength multiplex is carried out, it is desirable to operate the optical multiplex board of the invention in this application, and to adjust level. However, level adjustment may be started after becoming a large level difference beyond this (for example, about 1dB). Moreover, it is desirable to always usually operate a tunable filter 11 and to detect the level of signal light.

[0011] It is also possible to assign the signal light of long wavelength most to the input port 5 of the optical multiplex board 17 among signal light contrary to an above-mentioned example, to assign signal light below to order with long wavelength, and to arrange the signal light of short

wavelength most to input port 8.

[0012] In the composition of drawing 1 , the number of the input port of the optical multiplex board may not be restricted to four, but the composition of eight ports or others is sufficient as it. Moreover, the output port of the optical multiplexing machine 9 can be made into one piece, an optical separator can be arranged, and wavelength multiplex light can also be branched to two. CPU10 can also be equipped with the external-control port 14 because of the tandem composition mentioned later.

[0013] The good light variation attenuator and tunable filter which are used in the above-mentioned example of composition are well-known equipment, are controlling current or voltage, and can adjust the magnitude of attenuation and a transmitted wave length region, respectively. Since the optical multiplex board of the composition of drawing 1 always detects the level of each signal light by the tunable filter 11 and PD12 and CPU10 can adjust the level of signal light to a predetermined value automatically, always exact level adjustment is possible.

[0014] Drawing 2 arranges two or more optical multiplex boards shown in drawing 1 , and when signal light is 16, it is the composition of the tandem connection of the optical multiplex board. The optical multiplex boards 18, 19, 20, and 21 equipped with four input port, respectively are arranged, and incidence of the output light of the these light multiplex board is carried out to four input port of the optical multiplex board 17, respectively. The optical multiplex board 17 carries out multiplex [ of such signal light ], and outputs them. The CPU board 16 has connected with the external-control port of two or more above-mentioned multiplex boards, and performs the same level adjustment control as drawing 1 . With the composition of drawing 2 , 16 signal light is arranged in order with wavelength short from the 1st input port of the optical multiplex board 18 to the 4th input port of the optical multiplex board 21, or order with long wavelength. Thus, even if signal light increases with constituting, these level adjustments can always be performed automatically.

[0015] The operation of the optical multiplex board of the composition of drawing 2 is as follows. By the optical multiplex boards 18, 19, 20, and 21, the same operation as what explained drawing 1 , respectively is performed first. Incidence of the output light of each [ these ] multiplex board is carried out to the optical multiplex board 17. The optical multiplex board 17 detects the level of these four signal light, and adjusts level. In this case, the CPU board 16 changes the value of the reference level currently held among the four above-mentioned optical multiplex boards at CPU10 in the required optical multiplex board of level adjustment based on the level information acquired from CPU10 in the optical multiplex board 17. Level adjustment is performed so that it may double with the still newer reference level in the optical multiplex board concerned.

[0016]

[Effect of the Invention] Since the level for every wavelength is detected for two or more signal light by which wavelength multiplex was carried out by the tunable filter and the optical light sensing portion in this invention, a control section controls each good light variation attenuator and the level of each signal light is adjusted to a predetermined value as above, level adjustment of signal light by which wavelength multiplex is carried out can be performed automatically and correctly.

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**DESCRIPTION OF DRAWINGS**

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[Brief Description of the Drawings]

[Drawing 1] The block diagram showing the example of composition of the optical multiplex board of this invention.

[Drawing 2] The block diagram showing the example of composition which carried out the tandem connection of the optical multiplex board of this invention.

[Drawing 3] The block diagram showing the composition of the conventional optical multiplex board.

[Description of Notations]

1, 2, 3, 4 Good light variation attenuator

5, 6, 7, 8 Input port

9 Optical Multiplexing Machine

10 Control Section (CPU)

11 Tunable Filter

12 Photodiode

13 Optical Output Port

14 External-Control Port

15 AD Converter

16, 17, 18, 19, 20, 21 Optical multiplex board

22 Optical Spectrum Analyzer

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[Translation done.]

(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平10-276173

(43) 公開日 平成10年(1998)10月13日

(51) Int.Cl.<sup>6</sup>

識別記号

F I

H 0 4 J 14/00

H 0 4 B 9/00

E

14/02

G 0 2 B 6/28

B

G 0 2 B 6/293

審査請求 有 請求項の数 6 O L (全 6 頁)

(21) 出願番号 特願平9-78637

(22) 出願日 平成9年(1997)3月28日

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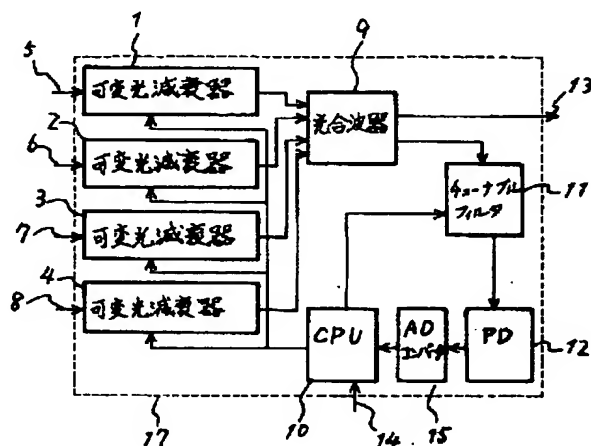
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(54) 【発明の名称】 光多重盤及び光多重方法

(57) 【要約】

【課題】従来光多重盤内で波長多重される複数の信号光のレベルを均一に調整する場合、熟練作業者が測定器を用いて手動で行わざるを得なかった。

【解決手段】光多重盤内で波長多重された信号光をチューナブルフィルタを透過させフォトダイオードで各波長毎にそのレベルを測定し、そのレベル値に基づいて制御部が可動光減衰器を調整して各レベルを一定の値に合わせる。これにより、波長多重される信号光のレベルを常時、自動的に調整できる。





**【特許請求の範囲】**

【請求項1】複数の入力部からそれぞれ信号光を入力させ、これら複数の信号光を多重して出力する光多重盤において、信号光が入力する複数の可変光減衰器と、各可変光減衰器からの出力光を合波する光合波器と、前記光合波器の出力光が入力するチューナブルフィルタと、前記チューナブルフィルタからの出力光を受光する光受光部と、前記光受光部の出力に基づき各可変光減衰器を制御する制御部とを備えたことを特徴とする光多重盤。

【請求項2】請求項1の光多重盤を複数備え、前記各光多重盤から出力する信号光を複数の入力部から入力させ、これらの信号光を多重する光受信盤と、前記全ての光受信盤を制御する制御盤を備えたことを特徴とする光多重盤。

【請求項3】前記光合波器は2つの出力ポートを有し、一方の出力ポートに前記チューナブルフィルタが接続している請求項1または2に記載の光多重盤。

【請求項4】前記光合波器の出力光は光分波器で分岐され、一方の分岐光が前記チューナブルフィルタに入力する請求項1または2に記載の光多重盤。

【請求項5】複数の信号光を可変光減衰器を介して入力せしめ、これらを波長多重した後各信号光のレベルを検知し、前記可変光減衰器を制御することによって各信号光のレベルを所定のレベルに調整することを特徴とする光多重方法。

【請求項6】各信号光のレベルを検知し、これらのうち最小のレベルに各信号光のレベルを合わせるように前記可変光減衰器を制御する請求項5に記載の光多重方法。

**【発明の詳細な説明】**

【発明の属する技術分野】本発明は波長多重方式の光伝送システムに用いられ、複数の信号光を多重する光多重盤に関する。

**【0001】**

【従来の技術】波長多重方式の光伝送システムでは、多重される各信号光のレベルに差が生じると受信側で信号光を正確に受信できないという問題が生じる。信号光のレベルを描える方法としては送信側の各光源のレベルをモニタして所定のレベルに調整する方法が知られている。これに対して、より正確なレベル調整を行うために、光伝送路において複数の信号光の波長を多重させる光多重盤において各信号光のレベルを調整する方法が行われている。

【0002】図3は、上記機能を有する従来の光多重盤の構成を示す。4台の手動の可変光減衰器1、2、3、4が光合波器9と接続しており、該光合波器9の出力側には光スペクトルアナライザ22が接続している。この多重盤では、保守者が光スペクトルアナライザ22により各波長ごとの出力レベルを測定し、手動で可変光減衰器1、2、3、4のそれぞれの減衰量を調整し、各波長のレベルを一定に調整する。

**【0003】**

【発明が解決しようとする課題】しかし、上述のように従来の光多重盤では、作業に熟練した保守者と測定器を確保する必要があり、また常に各信号光のレベルを一定に保つことは困難である。

【0004】本発明の目的は、各信号光のレベルを自動的に常に一定に調整することができる光多重盤を提供することにある。

**【0005】**

【課題を解決するための手段】上記目的を達成する本発明の光多重盤は、信号光が入力する複数の可変光減衰器と、各可変光減衰器からの出力光を合波する光合波器と、前記光合波器の出力光が入力するチューナブルフィルタと、前記チューナブルフィルタからの出力光を検知する光受光部と、前記光受光部の出力に基づき各可変光減衰器を制御する制御部とを備えている。また本発明の光多重盤の他の構成は、上記光多重盤を複数備え、これらの出力光をさらに上記構成の多重盤に入力せしめ、これら複数の多重盤を制御する制御盤を備えた構成である。

【0006】次に、本発明の光多重方法は、複数の信号光を可変光減衰器を介して入力せしめ、これらを波長多重した後各信号光のレベルを検知し、前記可変光減衰器を制御することによって各信号光のレベルを所定のレベルに調整するものである。

【0007】本発明では、チューナブルフィルタと光受光部によって各信号光のレベルを検知し、制御部が各可変光減衰器を制御し各信号光のレベルを所定の値に調整するので、波長多重される信号光同士のレベル調整を自動的にかつ正確に行うことができるというすぐれた効果を奏する。

**【0008】**

【発明の実施の形態】次に、本発明に実施の形態について図面を用いて説明する。図1は本発明の光多重盤の基本構成を示す。光多重盤17の4つの入力ポート5、6、7、8にそれぞれ可変光減衰器1、2、3、4の入力部が接続している。上記4つの可変光減衰器1、2、3、4は光合波器9に接続している。光合波器9は2つの出力ポートを有し、一方の出力ポートは光多重盤17の光出力ポート13に接続している。また光合波器9の他方の出力ポートはチューナブルフィルタ11に接続している。チューナブルフィルタ11にはフォトダイオード(PD)12、ADコンバータ15、制御部(CPU)10がこの順番でシリーズに接続している。CPU10はチューナブルフィルタ11と4つの可変光減衰器1、2、3、4と接続し、これらを制御することができる。またCPU10には外部から該CPU10を制御するための外部制御ポート14が接続している。

【0009】次に、上記光多重盤17の動作例について説明する。まず入力ポート5へ最も短波長の信号光が入

射し、以下入力ポート6、7、8へ短波長から長波長の順で各信号光が入射する。これら4つの信号光はそれぞれ可変光減衰器1、2、3、4を透過し、光合波器9に入射する。可変光減衰器は初期状態として透過率100%としておく。光合波器9はこれら4つの信号光を波長多重し2つの出力ポートから送出する。一方の波長多重光は光多重盤17の光出力ポート13から送出される。他方の波長多重光はチューナブルフィルタ11に入射する。チューナブルフィルタ11は、その透過特性を波長多重光のうちの最短波長側から長波長側へ順次変化させるようにCPU10により制御され、駆動している。PD12はチューナブルフィルタ11を透過する信号光を受光し、そのレベルに関する信号をADコンバータ15に送る。ADコンバータ15はこの信号光のレベルを示す信号をデジタル信号に変換し、CPU10に送る。CPU10はチューナブルフィルタ11がスキャンニング駆動して透過せしめる最初の信号光が最短波長であるようにチューナブルフィルタ11を制御している。したがってCPU10は、保持している所定の基準レベルに最初の信号光のレベルを合わせるよう可変光減衰器1を制御する。以下チューナブルフィルタ11は波長順に信号光を透過させるので、他の波長の信号光についても上述の操作を順次行う。

【0010】上記CPU10が保持する所定の基準レベルは4つの信号光のうちの最小の信号光のレベル値とすることができる。この場合CPUは、可変光減衰器1の制御を開始する前に4つの信号光のレベルを検知し、これらのレベルのうち最小のレベル値を基準レベル値として保持しておく。上記以外の値を基準値に選ぶこともできる。また可変光減衰器1の初期設定値を透過率100%より小さい値にしておくこともできる。システムの設計によって異なるが、波長多重される複数の信号光のレベルの間におよそ0.2dBから0.3dBの差が生じた場合に、本願発明の光多重盤を動作させレベルの調整を行うことが望ましい。しかしこれ以上の大きいレベル差（例えば1dB程度）になってからレベル調整を開始する場合もある。また通常はチューナブルフィルタ11を常に動作させ、信号光のレベルを検知しておくことが望ましい。

【0011】上述の例とは逆に光多重盤17の入力ポート5に信号光のうち最も長波長の信号光を割り当て、以下波長の長い順に信号光を割り当て、入力ポート8に最も短波長の信号光を配置することも可能である。

【0012】図1の構成において、光多重盤の入力ポートの数は4つに限られず、8ポートまたはその他の構成でもかまわない。また光合波器9の出力ポートを1個とし、光分波器を配置して、波長多重光を2つに分岐させることもできる。CPU10は後述するタンデム構成のために外部制御ポート14を備えることもできる。

【0013】上記構成例で用いる可変光減衰器、チュー

ナブルフィルタは公知の装置であり、電流または電圧を制御することで、それぞれ減衰量、透過波長域を調整できるものである。図1の構成の光多重盤はチューナブルフィルタ11とPD12により常に各信号光のレベルを検知し、CPU10が自動的に信号光のレベルを所定値に調整できるので、常時正確なレベル調整が可能である。

【0014】図2は図1に示した光多重盤を複数配置し、信号光が16の場合に対応する光多重盤のタンデム接続の構成である。入力ポートをそれぞれ4個備える光多重盤18、19、20、21を配置し、これら光多重盤の出力光を光多重盤17の4つの入力ポートにそれぞれ入射させる。光多重盤17はこれらの信号光を多重し、出力する。CPU16は上記複数の多重盤の外部制御ポートと接続しており、図1と同様のレベル調整制御を行う。図2の構成では、16個の信号光を光多重盤18の第1入力ポートから光多重盤21の第4入力ポートまで波長の短い順に、または波長の長い順に配置する。このように構成することで信号光が増加してもこれらのレベル調整を常時、自動的に行うことができる。

【0015】図2の構成の光多重盤の動作は次のとおりである。まず光多重盤18、19、20、21では、それぞれ図1について説明したものと同様の動作が行われる。これら各多重盤の出力光は光多重盤17に入射する。光多重盤17はこれら4つの信号光のレベルを検知し、レベルを調整する。この場合、CPU16は光多重盤17内のCPU10から得たレベル情報に基づき、上記4つの光多重盤のうちレベル調整の必要な光多重盤内のCPU10に保持されている基準レベルの値を変化させる。さらに当該光多重盤では新たな基準レベルに合わせるようにレベル調整が行われる。

【0016】

【発明の効果】以上のとおり、本発明では、波長多重された複数の信号光をチューナブルフィルタと光受光部によって各波長毎のレベルを検知し、制御部が各可変光減衰器を制御し各信号光のレベルを所定の値に調整するので、波長多重される信号光同士のレベル調整を自動的かつ正確に行うことができる。

【図面の簡単な説明】

【図1】本発明の光多重盤の構成例を示すブロック図。

【図2】本発明の光多重盤をタンデム接続した構成例を示すブロック図。

【図3】従来の光多重盤の構成を示すブロック図。

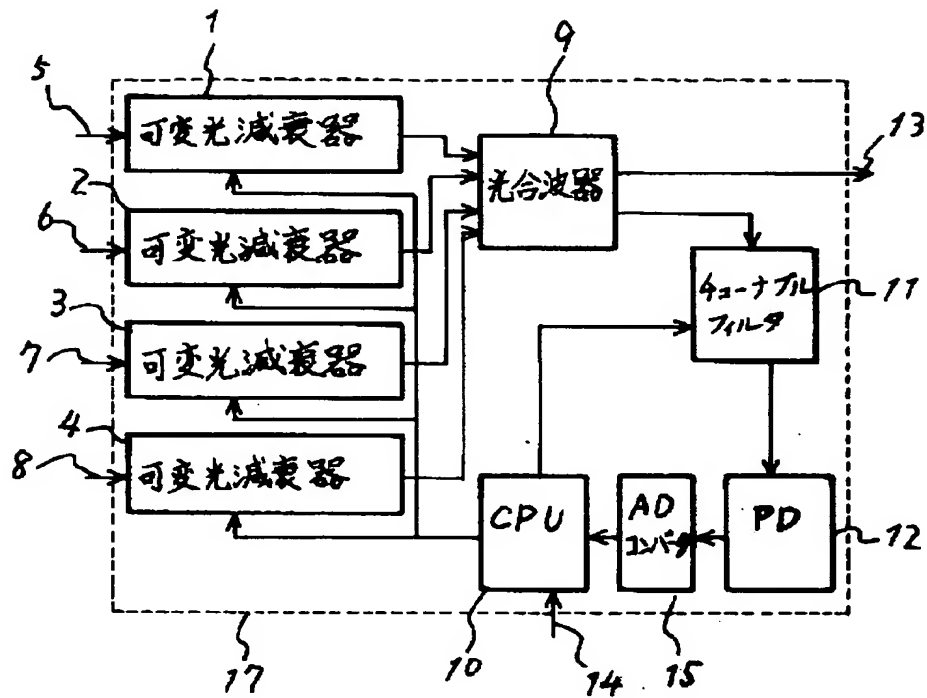
【符号の説明】

- 1、2、3、4 可変光減衰器
- 5、6、7、8 入力ポート
- 9 光合波器
- 10 制御部(CPU)
- 11 チューナブルフィルタ
- 12 フォトダイオード

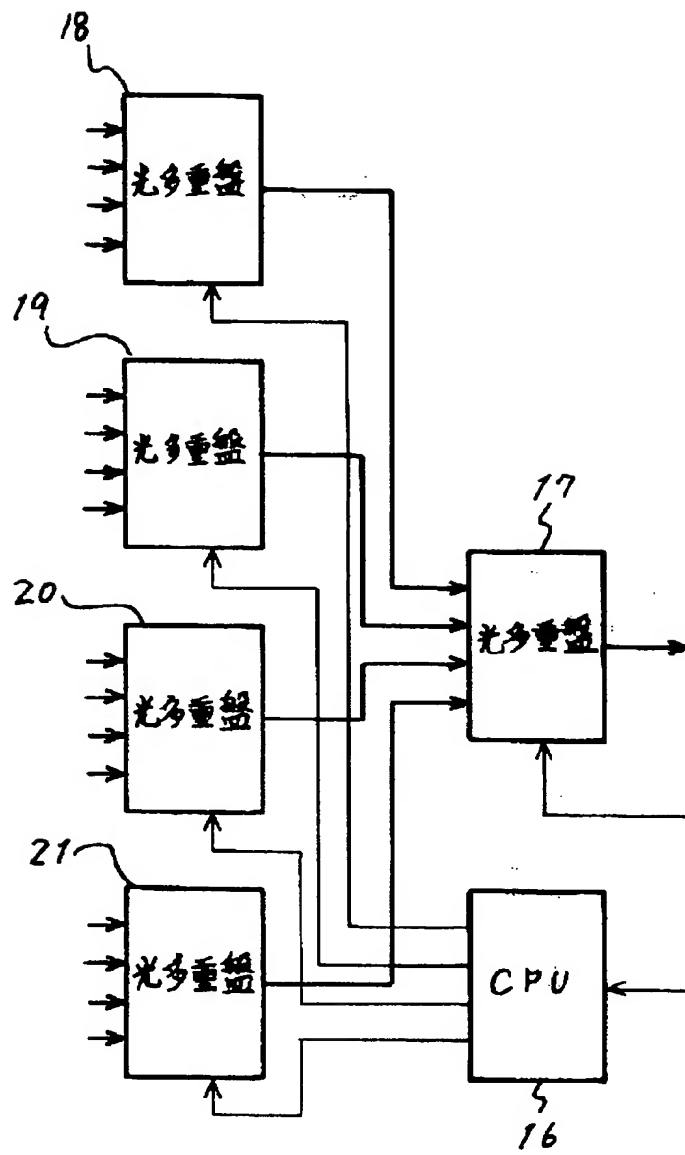
13 光出力ポート  
14 外部制御ポート  
15 ADコンバータ

16、17、18、19、20、21 光多重盤  
22 光スペクトルアナライザ

【図1】



【図2】



【図3】

